Contents

Chapter 1 Fundamental and Metrological Concepts in Analytical Chemistry 1

1.1 Introduction 1
1.2 Definitions of Analytical Chemistry 2
1.3 Concepts used in Laboratory Practice 2
1.4 Concepts Related to Properties, Quantities And Units 9
1.5 Concepts on Measurement and Examination 18
1.6 Concepts Related to Measurement Error and Measurement Uncertainty 25
1.7 Concepts Related to Calibration 34
1.8 Terms, Symbols, Definitions and SI Units of Quantities and Constants 41
1.8.1 Quantities Answering the Question ''How Much Material?'' 41
1.8.2 Quantities Describing the Composition of a Material 41
1.8.3 Examples of Quantities Applied in Various Subdisciplines of Analytical Chemistry 43
1.8.4 Adjectives Modifying Quantity Terms 45
1.8.5 Defining Constants of the International System of Units 46
1.8.6 SI-Derived Units with Special Terms and Symbols 46
1.9 Checklist for Making Measurements in Analytical Chemistry 47
1.10 Presentation of Quantities and Their Values 48
1.10.1 Quantity and Value 48
1.10.2 Numerical Quantity Value 48
1.10.3 Measurement Unit 48
1.10.4 Spacing 49
1.10.5 Measurement Result 49
1.10.6 Measurement Uncertainty 49
1.10.7 Symbol for Quantity 49
1.10.8 Italic and Roman Font Style 49
1.10.9 Tables and Diagrams 49
1.10.10 Equations 50
Acknowledgements 51
References 51

Chapter 2 Chemometrics 55

2.1 Introduction 55
2.2 Data, Sampling and Data Processing 56

Compendium of Terminology in Analytical Chemistry
Edited by D. Brynn Hibbert

© International Union of Pure and Applied Chemistry 2023

Published by the Royal Society of Chemistry, www.rsc.org

Downloaded from http://books.rsc.org/books/edited-volume/chapter-pdf/1742543/bk9781782629474-fp019.pdf by guest on 30 October 2025

2.3 Experimental Design 60
2.4 Multivariate Methods and Related Concepts 63
2.5 Classification 71
2.6 Calibration and Regression 78
References 81

Chapter 3 Extraction for Sample Preparation 83

3.1 Introduction 83
3.2 General Terms 85
3.2.1 General Terms (Fundamental Processes) 85
3.2.2 General Terms (Process Technology) 87
3.3 Extraction Techniques 92
3.3.1 Gas-Phase Extraction 92
3.3.2 Liquid–Liquid Extraction 96
3.3.3 Extraction of Solids by a Fluid 99
3.3.4 Digestion Methods 102
3.3.5 Solid-phase Extraction 103
3.3.6 Solid-Phase Microextraction Techniques 108
3.3.7 Membrane Extraction 110
3.3.8 Automated and High-throughput Extraction Methods-Advanced Flow Technology 113
References 116

Chapter 4 Mass and Volume in Analytical Chemistry 119

4.1 Introduction 119
4.2 Foundations of Quantitative Chemical Measurements 119
4.2.1 The Decimal Metric System 119
4.2.2 SI Units for Mass, Volume and Amount of Substance 120
4.2.3 Mass: Kilogram 121
4.2.4 Volume and Time: Metre and Second 122
4.2.5 Amount of Substance: Mole 123
4.3 Measurement of Mass 123
4.3.1 Types of Balances 124
4.3.2 Calibrating Weights 124
4.3.3 Mass in Air and a Vacuum 125
4.3.4 Piezoelectric Measurement of Mass 125
4.4 Measurement of Volume 126
4.4.1 Volumetric Glassware Tolerances and Calibration 126
4.5 Solutions 126
4.5.1 Preparation of Solutions 127
4.5.2 Solutions Prepared by Dilution 128
4.5.3 Preparation of Standard Solutions 128
4.5.4 Stoichiometry and Equivalence in Titrations 129
4.6 Methods of Analysis Depending on Measurement of Mass 129
4.6.1 Gravimetric Analysis by Direct Weighing of the Analyte 129
4.6.2 Gravimetric Analysis of Precipitates 130
4.6.3 Gravimetric Analysis Involving Vapours 130
4.6.4 Thermogravimetric Analysis 130
4.7 Methods of Analysis Depending on Measurement of Volume 131
4.7.1 Kinds of Titrations 131

Downloaded from http://books.rsc.org/books/edited-volume/chapter-pdf/1742543/bk9781782629474-fp019.pdf by guest on 30 October 2025

4.7.2 Requirements for a Titration 131
4.7.3 Direct and Back Titration 132
4.7.4 Visual Indicators 132
4.7.5 Complexometric Indicators 133
4.7.6 Redox Indicators 135
4.7.7 Adsorption and Precipitation Indicators 136
4.7.8 Instrumental Indicators 136
4.7.9 Examples 138
4.8 Quality of Results 139
4.8.1 Aspects of Quality 139
4.8.2 Uncertainty Associated with Mass Measurement 140
4.8.3 Uncertainty Associated with Volume Measurement 141
4.8.4 Measurement Uncertainty Associated with Preparing Standard Solutions 142
4.8.5 Uncertainty Associated with Titration 143
4.9 Glossary of Terms 145
References 151

Chapter 5 Separation in Analytical Chemistry 154

5.1 Introduction 154
5.2 Chromatography 155
5.2.1 Basic Terms and Definitions 155
5.2.2 Principal Methods 156
5.2.3 Classification According to the Shape of the Chromatographic Bed 157
5.2.4 Classification According to the Physical State of the Mobile Phase 157
5.2.5 Classification According to the Mechanism of Separation 158
5.2.6 Classification According to the Mode of Elution 160
5.2.7 Terms Related to the Chromatographic Process and the Theory of Chromatography 162
5.2.8 Terms Expressing the Efficiency of Separation 169
5.2.9 Classification of Detectors 170
5.2.10 Supercritical Fluid Chromatography and Extraction 171
5.2.11 Counter-current Chromatography, (CCC) 171
5.2.12 Ion-exchange Chromatography 174
5.2.13 Enantioselective, (chiral) Chromatography 175
5.2.14 Two-dimensional Chromatography 176
5.2.15 Exclusion Chromatography 177
5.3 Electromigration Techniques 180
5.4 Field-flow Fractionation and Related Techniques 184
References 188

Chapter 6 Analytical Spectroscopy 190

6.1 Introduction 190
6.2 General Terms 191
6.2.1 Kinds of Spectroscopy 191
6.2.2 Basic Terms Relating to Electromagnetic Radiation 191
6.2.3 General Terms Related to Spectroscopy 202
6.2.4 General Terms Relating to Instrumentation in Spectroscopy 208

Downloaded from http://books.rsc.org/books/edited-volume/chapter-pdf/1742543/bk9781782629474-fp019.pdf by guest on 30 October 2025

6.2.5 Fundamental Functions and Mathematical Data Treatment 212
6.3 NMR Spectroscopy 213
6.3.1 Basic NMR Terms 214
6.3.2 Experimental Terminology in NMR 220
6.3.3 Named NMR Experiments 228
6.4 Atomic Spectroscopy 237
6.4.1 Methods of Atomic Spectroscopy 238
6.4.2 General Terms used in Atomic Spectroscopy Techniques 240
6.4.3 Terms Relating to Atomic Emission Spectroscopies 243
6.4.4 Terms Relating to Atomic Absorption Spectroscopies, (AAS) 253
6.5 Vibrational Spectroscopy 255
6.5.1 Introduction to Vibrational Spectroscopy 255
6.5.2 Methods in Vibrational Spectroscopy 256
6.5.3 Terms in Vibrational Spectroscopy 258
Acknowledgements 278
References 278

Chapter 7 Mass Spectrometry 281

7.1 Introduction 281
7.2 Terms in Mass Spectrometry 281
References 335

Chapter 8 Electroanalytical Chemistry 344

8.1 Introduction 344
8.2 Fundamental Electrochemical Terms 344
8.3 General Terms in Electroanalytical Chemistry 351
8.4 Electrode Systems 355
8.4.1 Classification of Electrodes by Size 355
8.4.2 Classification of Electrodes by Function 356
8.4.3 Classification of Electrodes by Chemical Composition 357
8.4.4 Other Electrode Systems 361
8.5 Electroanalytical Techniques 367
8.5.1 Potentiometry and Related Techniques 367
8.5.2 Amperometry and Related Techniques 368
8.5.3 Voltammetry and Related Techniques 368
8.5.4 Electrochemical Pre-concentration/Stripping Methods 378
8.5.5 Coulometry and Related Techniques 381
8.5.6 Electrogravimetry and Related Techniques 383
8.5.7 Conductometry and Related Techniques 383
8.5.8 Methods Based on Measurement of Impedance 384
8.5.9 Combined Methods 385
References 385

Chapter 9 Radioanalytical Chemistry 388

9.1 Introduction 388
9.2 General Terms in Radiochemistry 389
9.3 Measurement of Radiation 397
9.4 General Terms in Radioanalytical Chemistry 402
9.5 Measurement using Particles 404

Downloaded from http://books.rsc.org/books/edited-volume/chapter-pdf/1742543/bk9781782629474-fp019.pdf by guest on 30 October 2025

9.6 Measurement using High-Energy Photons 409
9.7 Measurement Using Nuclides 412
References 415

Chapter 10 Analytical Chemistry of Surfaces 419

10.1 Introduction 419
10.2 Surface Chemical Analytical Methods 420
10.2.1 Electron Spectroscopies 420
10.2.2 Ion Scattering Spectroscopies 422
10.2.3 Mass Spectrometries 424
10.2.4 Optical and X-Ray Spectroscopies 427
10.3 Terms used in Surface Chemical Analysis 433
10.3.1 General Terms 433
10.3.2 Electron Spectroscopy 469
10.3.3 Ion Scattering Spectroscopy 488
10.3.4 Mass Spectrometry 494
10.3.5 Optical and X-Ray Spectroscopy 499
References 501

Chapter 11 Thermal Analysis 503

11.1 Introduction 503
11.1.1 Historical Matters 503
11.2 Definition of the Field Of Thermal Analysis (TA) 504
11.3 Measurement Principles 504
11.4 Terminology and Glossary 505
11.5 Symbols Used in Thermal Analysis 510
11.6 Reporting Experimental Data 510
References 511

Chapter 12 Bioanalytical Chemistry 512

12.1 Introduction 512
12.2 Bioanalytical Samples 513
12.3 Analysis of Biomolecules 516
12.3.1 General Terms 516
12.3.2 Enzymatic Methods 519
12.3.3 Immunoanalytical Methods 523
12.3.4 Genomics and Nucleic Acid Analysis 529
12.3.5 Proteomics 539
12.3.6 Metabolomics 548
12.3.7 Glycomics 551
12.3.8 Lipidomics 556
12.4 Studies of the Interactions Between Biomolecules 562
References 565

Chapter 13 Quality in Analytical Chemistry 569

13.1 Introduction 569
13.2 General Concepts Related to Quality and Quality Management 570
13.3 Concepts Related to Validation and Verification of Analytical Procedures 575

Downloaded from http://books.rsc.org/books/edited-volume/chapter-pdf/1742543/bk9781782629474-fp019.pdf by guest on 30 October 2025

13.4 Concepts Related to Reference Materials 577
13.5 Concepts Related to Intra- and Interlaboratory Comparisons 581
13.6 Concepts Related to Internal Quality Control 587
13.7 Concepts Related to Conformity Assessment, Quality Specifications and Measurement Quality 590
References 595

Appendix **598**

Index **604**

Index of Symbols **644**

Index of Acronyms, Abbreviations and Initialisms **654**

Downloaded from http://books.rsc.org/books/edited-volume/chapter-pdf/1742543/bk9781782629474-fp019.pdf by guest on 30 October 2025